

CITY OF CUPERTINO GENERAL PLAN AMENDMENT

1-GPA-80

TECHNICAL APPENDIX - E

NOISE IMPACTS AND MITIGATION STUDY

INSTITUTE OF GOVERNMENTAL
STUDIES, UC BERKELEY

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CUPERTINO GENERAL PLAN AMENDMENT PROJECT

Noise Section

INTRODUCTION -- This study is focused upon the potential noise impacts which may occur under two future (1990) development scenarios for Cupertino:

- (1) Growth and development occurring under 1979 General Plan policies.
- (2) Growth and development occurring under adopted 1983 General Plan Amendment policies.

Comparisons are made between these two cases and also with existing noise conditions.

The basic difference in the two future cases is in allowed intensity of commercial development in the Vallco, Town Center, and the adjacent Stevens Creek Boulevard and De Anza Boulevard areas. No significant differences exist in specific locations to be developed or in the mix types of development. Hence, the noise differences to be evaluated lie primarily in the number of new trips which may be drawn to these developments along major access routes, as projected by the City traffic model for 1990.

I. Existing Setting

A. Noise Sources in the Project Area

Cupertino is subject to traffic noise from a significant number of major roadways, and is divided by Interstate 280 Freeway. Most areas of the City have at least one large-volume street nearby providing the dominant noise environment, or contributing substantially to the background noise level. Major streets carry average daily traffic (ADT) volumes of 15,000 up to approximately 130,000 for I-280. The primary traffic noise sources are shown on Exhibit 1 Noise Contour Map, which was prepared for the General Plan Noise Element (1979). The day-night noise contours (Ldn) show the approximate roadside locations where 60 and 70 dBA noise levels occur. (See the Appendix for definitions of noise concepts and terminology.)

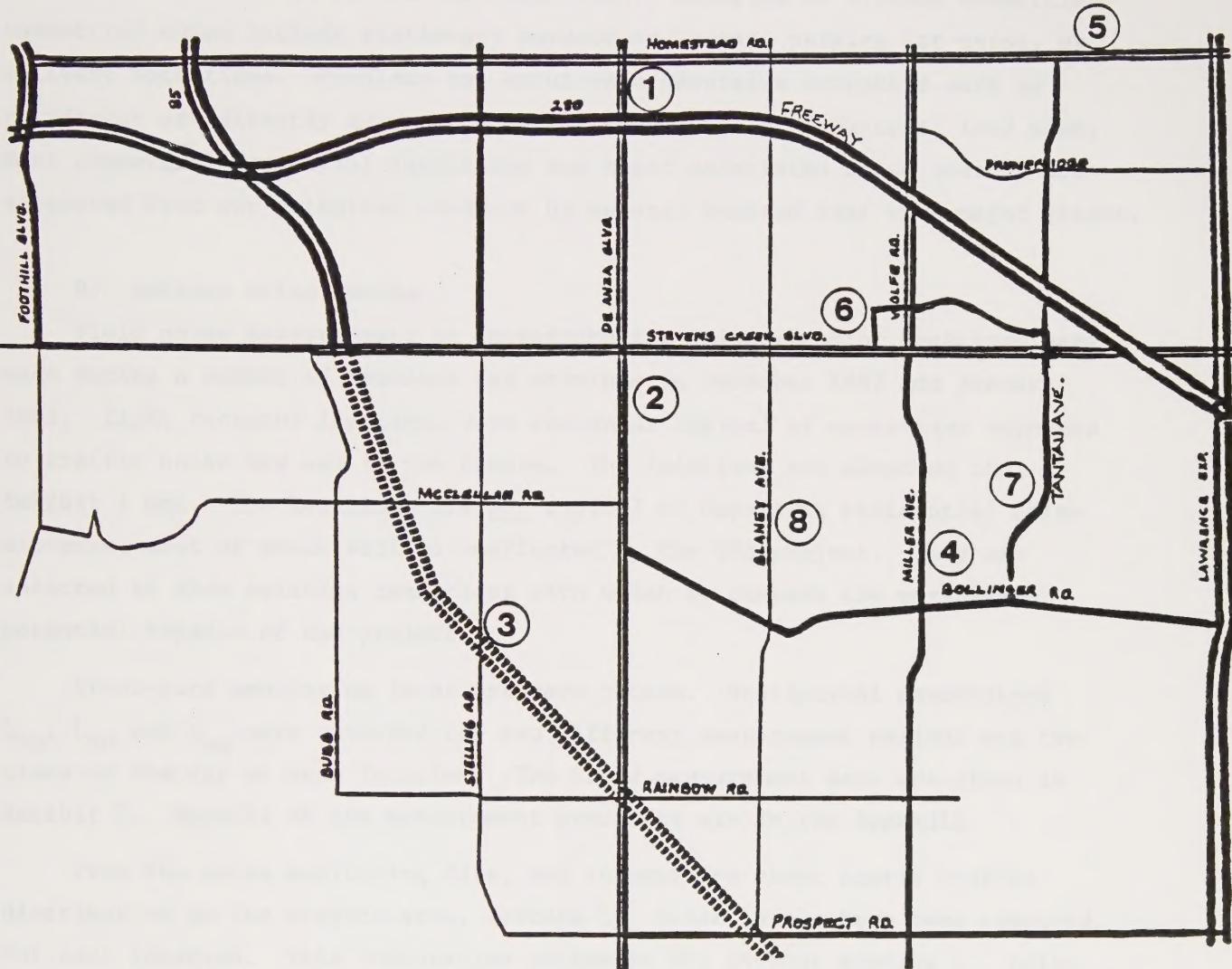
The majority of vehicles are standard automobiles, vans, and small trucks, which individually produce noise levels of 55 to 65 dBA at 50 feet when passing at modest speed. Medium and large trucks, buses, and motorcycles make up only about 10 percent of the vehicles, but generally produce passby noise levels 10 to 20 dBA higher than automobiles under the same conditions. Vehicles with faulty muffler systems produce noise levels in the same range as trucks and motorcycles.

Other noise sources in the Cupertino area are present, but their contributions are much less significant because of the small frequency of occurrence. The proposed General Plan Amendment does not affect these noise sources or their impacts, but they will be discussed briefly for comparison with traffic noise.

Approximately one train per day travels the Southern Pacific spur at the west end of the City to and from Kaiser Permanente Plant. Noise levels of 85 - 90 dBA at a distance of 50 feet are produced for a period of about two minutes for each passby.

Sporadic aircraft flyovers occur in the project area. Turboprop submarine patrol aircraft and other military planes skirt the eastern edge of Cupertino as they approach Moffett Field Naval Air Station six miles to the north. Noise levels of 60 to 70 dBA may occur several times per hour from these operations.

EXHIBIT 1
CUPERTINO GPA AREA MAP



n Noise Monitoring and Receptor Locations

San Jose International Airport is six miles to the northeast, but the approach and takeoff patterns do not bring aircraft over the project area.

Noticeable contributions to local noise environments may be made by specific commercial or industrial businesses. Examples of typical commercial/industrial noise include stationary outdoor equipment, parking lot noise, or delivery operations. Problems may occur when sensitive receptors such as residences are directly adjacent to these commercial or industrial land uses. Most commercial/industrial facilities and their associated noise sources are separated from any potential receptor by several hundred feet or a major street.

B. Ambient Noise Levels

Field noise measurements at representative noise receptor locations were made during a number of weekdays and evenings in December 1982 and January 1983. Eight receptor locations were chosen as typical of worst-case exposure to traffic noise now and in the future. The locations are shown on the Exhibit 1 Map. The locations are not typical of Cupertino residential noise exposure, most of which will be unaffected by the GPA project. They are selected to show existing conditions with which to compare the worst-case potential impacts of the project.

Front-yard monitoring locations were chosen. Statistical descriptors L_{50} , L_{90} and L_{eq} were recorded for two different measurement periods and two times of the day at each location. The field measurement data are given in Exhibit 2. Details of the measurement procedure are in the Appendix.

From the noise monitoring data, and information about hourly traffic distribution in the project area, average L_{dn} noise levels have been computed for each location. This computation estimates the 24-hour average L_{eq} noise level, with a nighttime penalty of 10 dB to account for the fact that the nighttime period is expected to be significantly more quiet than the daytime.

Noise levels at each monitoring location, and at receptor locations in general, are dependent upon four major factors: nearby traffic volumes, average traffic speeds, distance to the roadway, and the size of obstructions between noise source and receptor. To better assess potential project impact,

EXHIBIT 2

AMBIENT NOISE ENVIRONMENT (dBA)
CUPERTINO GENERAL PLAN AMENDMENT PROJECT AREA

<u>Location</u>	<u>Period</u>	<u>Measurements</u>				<u>Estim. (24-hr) L_{dn}</u>
		<u>L₉₀</u>	<u>L₅₀</u>	<u>L₁</u>	<u>L_{eq}</u>	
1. De Anza Blvd. at Mariani's	morning	60	68	76	71	73
	afternoon	63	68	76	71	
2. De Anza Blvd. near Rodriques	afternoon	58	65	75	68	70
	evening	54	58	73	65	
3. Stelling Rd. near Highway 85	afternoon	50	63	72	66	69
	evening	48	58	71	64	
4. Miller Ave. N. of Bollinger Rd.	morning	53	61	73	65	66
	night	45	51	67	58	
5. Homestead Rd. E. of Tantau Ave.	morning	54	63	75	68	70
	afternoon	56	65	77	69	
6. Wheaton Drive near Vallco Peri- meter Road	morning	44	47	63	53	53
	afternoon	48	51	64	54	
7. Tantau Avenue S. of Barnhart	morning	44	55	68	60	62
	afternoon	46	56	71	62	
8. Blaney Avenue S. of Pacifica	morning	47	55	68	61	64
	afternoon	55	61	73	65	

major streets carrying increases in GPA-related traffic were chosen as receptors. Hence locations monitored have similar noise environments. Those locations which are separated from major roadways by distance, and one or more rows of houses, have much lower noise exposures.

The monitored noise levels reflect the volume, speed, and distance effects in a straightforward manner. No measurements were taken with significant obstructions between source and microphone. L_{dn} noise levels of 65 - 70 dBA for unprotected receptors along major routes are typical. The Cupertino Noise Element classifies noise environments below 70 dBA (L_{dn}) as "Normally Acceptable" for uses such as residential, park, school and hospital.

II. Potential Noise Impacts of Project

A. Sensitive Receptors

The receptors of concern are those residences, schools and parks adjacent to access routes to Vallco and Town Center. These commercial areas would have their development policies changed by the 1982 General Plan Amendment along with nearby sections of Stevens Creek Boulevard and north De Anza Boulevard. The primary access routes are Homestead Road, De Anza Boulevard, Wolfe Road, Miller Avenue, and Stevens Creek Boulevard. Secondary streets involved appear to be I-280, Stelling, Blaney, and Lawrence Expressway. In theory, the farther away from the Town Center/Vallco core an area is, the less effects and impacts will occur.

Representative receptors have been selected leading to the core area on primary and secondary access routes, to evaluate potential traffic-induced noise impacts. The selected locations correspond to the eight noise monitoring locations shown on Exhibit 1.

B. Data and Methodology

The potential noise impacts of the project are evaluated using projected traffic volumes and a version of the NCHRP Report 117 Traffic Noise Model (Ref. 6), which has been improved and validated on a continuous basis by the Consultant. Traffic volumes and characteristics for the three cases to be analyzed -- present traffic case, existing Plan - 1990, and the Preliminary GPA - 1990 -- were obtained from the City of Cupertino and from traffic studies related to the GPA and Vallco development projects (see the Traffic Section).

C. Project Noise Impact Analysis

The primary analysis for each receptor location involves modeling the L_{eq} noise level for the peak commute hour conditions. The 24-hour L_{dn} is also computed, using typical hourly distribution of traffic throughout the day. L_{dn} is generally less than the peak hour L_{eq} noise descriptor.

Exhibit 3 shows the anticipated changes in roadside L_{eq} noise levels for the eight representative receptor locations and the three traffic conditions. Each is computed for a distance of 50 feet from the center of the nearest traffic lane. Since traffic volumes are not expected to increase more than 20 to 30 percent, the maximum noise increase would be 2 dBA. For locations 6, 7, and 8, smaller streets where efforts to maintain present traffic volumes will be made, no noise increases are expected. Further assumptions in the analyses include no significant changes in average speeds or lane configuration between now and 1990.

There would also be noise associated with construction activities in developing Vallco and Town Center under the Preliminary Plan. However, there are no receptors close enough to these areas of development to produce noise above the existing ambient noise levels.

D. Discussion of Potential Noise Impacts

Maximum increases in roadside noise levels are projected to be two decibels on the major access streets (Exhibit 3). A two-decibel noise increase is generally not enough to be readily noticeable by most persons. For receptors on the major streets, receptors 1 through 5, the peak hour L_{eq} noise levels would be above 65 dBA at 50 feet. Although this is considered "normally acceptable" according to Cupertino Noise Element planning standards (Ref. 10, page 6-41), residential property noise levels above 60 are not desirable. However, the proposed project does not significantly increase the already high roadside noise levels.

On the secondary streets associated with Vallco access -- receptors 6, 7, and 8 -- traffic volumes and roadside noise levels are considerably lower. It is a GPA transportation policy to discourage traffic increases on minor collector streets, to provide environmental protection for residences. For

EXHIBIT 3
 CUPERTINO GENERAL PLAN AMENDMENT
 POTENTIAL NOISE IMPACTS AT REPRESENTATIVE LOCATIONS
 (Peak Hr L_{eq} Noise Level - dBA at 50 feet)

Location	Present Case	Change in Noise Level	
		Existing Plan (1990)	Preliminary GPA (1990)
1 Mariani (De Anza)	67	+2	+2
2 Town Center (De Anza)	67	+2	+2
3 Stelling Road (Jollyman)	68	+1	-2
4 Miller Avenue (Bollinger)	67	+1	+1
5 Homestead Road (E. of Tantau)	67	-	+1
6 Vallco West (Wheaton Drive)	54	-	-
7 Tantau Avenue (Hyde Jr. H.S.)	61	-	-
8 Blaney Avenue (Pacific)	63	-	-

Stelling Road (receptor 3), traffic management strategies to decrease volumes are planned for the same reasons. These traffic control policies are reflected in the 1990 noise projections for receptors 3, 6, 7, and 8.

III. General Noise Planning Considerations

A. Discussion of Noise Contours

Since 1976 public agencies in California have been responsible for providing noise contours describing transportation sources of noise within their jurisdictions (Ref. 9). This effort has had mixed results. While the intention to graphically identify noise levels produced by transportation sources is valid, the practical aspects of producing useful contours have caused difficulties. The major weaknesses of most noise contours includes inaccuracy of basic noise models, small map size, inability to reflect changed conditions, and difficulties in plotting and reading.

With the numerous contributors to inaccuracy, errors of ± 10 dB are not unlikely for a particular location on a contour map. What large-scale contours do is identify potential high noise locations, but they do not allow useful quantification of noise levels.

On the other hand, noise contours do have a valuable role for evaluating specific sites, when they can be developed from enough site noise measurements to adequately characterize both the sound sources and the site topographic/attenuation characteristics.

B. Introduction to Traffic Noise Profiles

A Traffic Noise Profile Matrix (TNPM) is a table of roadside noise levels associated with a typical set of traffic conditions, as shown in Exhibit A. Most of the range of traffic conditions encountered in Cupertino may be found on the Matrix, or can be estimated by interpolation between entries. For those traffic situations which are not represented on the table -- which have a different volume or speed, for example -- a chart of Corrections to TNPM Noise Levels (Exhibit B) is included to allow estimation of other noise levels.

The procedure for using the TNPM is as follows:

- a. Determine the hourly volume, average speed, and number of lanes for the street segment whose noise level you want to estimate. If there is a median, count it as a number of equivalent lanes (for example, a median twenty feet wide = two added lanes.) Keep in mind that volume (and often speed, also) changes throughout the day.
- b. Check the TNPM for the vehicle volume and speed which best fit the street in question. Interpolate between entries or use Corrections as needed.
- c. Note the estimated L_{50} and L_{eq} for the given traffic conditions.
- d. If a peak hour volume is used, the three right-hand columns give an estimate of the noise contour locations (L_{dn}).

Note: When using the TNPM, be aware of the inaccuracies and assumptions inherent in the simplified modeling method, as discussed in the next section. Full modeling computations should be utilized for complex or more critical applications.

C. Discussion of Traffic Noise Profile Matrix Modeling

The use of the TNPM is intended to reduce the weaknesses and inaccuracies encountered with noise contours. The method is based upon a version of the standard NCHRP Report 117 Traffic Noise Model developed by the Federal Highway Research Board (Ref. 6). This model has been improved by ECS and is validated on a continual basis by checking it against each traffic-related field noise measurement. Accuracy is ± 2 dB for a given set of traffic conditions.

The L_{dn} computations, on which the noise contours are based, involve using a typical 24-hour traffic distribution broken into seven periods. Noise levels are modeled for each traffic period and then summed over the day, with weighting for the evening hours, to obtain an L_{dn} estimate (See Appendix, Page A-1). A distance model is then used to compute to location of the 70, 65, and 60 dBA contours for each set of traffic conditions. Contours closer than 20 feet or farther than 200 feet from the near lane are not listed, since they are neither very accurate nor very useful in practice.

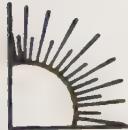
EXHIBIT A

CUPERTINO TRAFFIC NOISE PROFILE MATRIX

<u>Vehicles Per Hour</u>	<u>Speed (MPH)</u>	<u>Lanes</u>	<u>Noise Level (50 ft.)¹</u>		<u>Distance to Contour</u>		
			<u>L_{50}</u>	<u>L_{eq}</u>	<u>70²</u>	<u>65</u>	<u>60</u>
60	25	2	41	49	-	-	-
120	30	2	48	55	-	-	< 20
250	30	2	55	60	-	< 20	30
500	30	2	58	64	< 20	25	60
1,000	30	4	60	65	20	45	90
1,500	30	4	62	66	25	55	120
2,500	35	6	65	69	35	80	200
3,000	35	4	66	70	50	100	> 200
4,000	40	4	68	72	65	140	-
8,000	50	6	73	76	150	> 200	-
10,000	55	8	74	77	200	-	-

NOTES

1. L_{50} and L_{eq} are approximate hourly noise descriptors (± 2 dBA) for the traffic conditions given.
2. Contour descriptor is L_{dn} , a long-term average L_{eq} . The L_{dn} is computed for peak hour conditions listed, and a typical hourly traffic distribution. Distances (feet) measured from outside lane.
3. For conditions different than those listed, see Corrections sheet.



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EXHIBIT B

CORRECTIONS TO TNPM NOISE LEVELS

Base case parameters included in TNPM assumptions:

- .Vehicle speed, hourly volume, width of street (# lanes)
- .Distance: 50 ft. from outside lane
- .No significant obstructions or reflecting surfaces
- .Low grass or dirt ground cover

For conditions different than given on the TNPM, the following guidelines may be used for estimation:

VEHICLE VOLUME

For each 100% increase: Add 2-5 dB

For each 50% decrease: Subtract 2-5 dB
(Changes less at high volumes)

VEHICLE SPEED

For each 5 mph increase: Add 1-3 dB

For each 5 mph decrease: Subtract 1-3 dB
(Changes less at high speeds)

DISTANCE

For each 50% decrease: Add 3-6 dB

For 100% increase: Subtract 3-6 dB
(Changes more at greater distances and fewer lanes)

OBSTRUCTIONS, REFLECTING SURFACES, LANDSCAPING

Can be significant factors, but no simple guidelines can be stated.

IV. Project Mitigation Measures

Mitigation measures for traffic noise are most effectively focused upon reducing traffic volumes, average speeds, and eliminating vehicles with loud mufflers. Strategies for these goals are summarized below.

1. Implement methods for reducing traffic volumes and trips similar to those used in controlling air pollution emissions, termed Transportation Control Measures. See Exhibit 6 of Air Quality Study.
2. Enforce California Vehicle Code regulations controlling vehicles with faulty and modified noisy muffler systems, Sections 27150 and 27151.
3. Enforce City speed limits.
4. Protect minor collector residential streets from significant through-traffic volumes.
5. Encourage physical protection of sensitive receptors from traffic noise by establishment of satisfactory setback distances, earth berms, and barriers.

NOISE REFERENCES

1. Community Noise, U.S. Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D.C., December 1971.
2. Proceedings, Conference on Noise as a Public Health Hazard, American Speech and Hearing Assoc., Washington, D.C., June 1968.
3. Noise from Construction Equipment & Operations, Building Equipment, & Home Appliances, U.S. Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D.C., December 1971.
4. A Guide to Airborne, Impact and Structure-borne Noise Control in Multi-Family Dwellings, U.S. Department of Housing and Urban Development, Washington, D.C., September 1967.
5. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, U.S. Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D.C., March 1974.
6. Highway Noise - A Design Guide for Highway Engineers, National Cooperative Highway Research Program Report 117, Highway Research Board, Washington, D.C., 1971.
7. Highway Noise - A Field Evaluation of Traffic Noise Reduction Measures, NCHRP Report 144, Highway Research Board, Washington, D.C., 1973.
8. Noise Insulation Problems in Buildings, Report to Santa Clara County Airport Land Use Commission, Paul Veneklasen & Assoc., Santa Monica, CA, January 1973.
9. Guidelines for the Preparation and Content of Noise Elements of the General Plan, California Office of Noise Control, Berkeley, Feb. 1976.
10. Noise Element, Public Health and Safety Section of General Plan, Planning Department, City of Cupertino, 1979.

APPENDIX

Environmental Noise Measurement and Analysis Procedure

1. Select monitoring site in terms of existing noise sources, receptor areas, topography, and noise transmission characteristics.
2. Make field noise measurements of individual sources and long-term statistical variation on the project site (15-30 minutes at a time in each location). Equipment used:

Metrosonics Model 601 dB Noise Distribution Analyser
 Brüel and Kjaer Model 2206 Precision Sound Level Meter
 Brüel and Kjaer Model 4230 Calibrator
4. Record peak noise levels for individual sources and incidents, and the statistical descriptors of interest computed by the Noise Distribution Analyser, such as L_{50} , L_{10} and L_{eq} .
5. Based upon field measurements and transportation noise modeling data (for traffic, modified Highway Research Board Report 117), determine source/distance relationships on the site.
6. Compute L_{dn} values from measured statistical descriptors and typical variation of traffic volumes throughout the day:

Period	Hrs.	Hrly. Vol (% ADT)	Period	Hrs.	Hrly. Vol (% ADT)
A. 7 am - 9 am	2	7.5	D. 7 pm - 10 pm	3	4.0
B. 9 am - 4 pm	7	5.6	E. 10 pm - 12 Mid.	2	2.5
C. 4 pm - 7 pm (No peak)	2	7.0	F. 12 Mid- 7 am	7	0.7
			G. Peak Hour	1	10

To compute L_{dn} , where L_x is the L_{eq} for period X:

$$L_{dn} = 10 \log \frac{1}{24} \left\{ 2(10 \frac{L_A}{10}) + 7(10 \frac{L_B}{10}) + 2(10 \frac{L_C}{10}) + 3(10 \frac{L_D}{10}) + 2(10 \frac{L_E+10}{10}) + 7(10 \frac{L_F+10}{10}) + (10 \frac{L_G}{10}) \right\}$$

APPENDIX
Environmental Noise Concepts and Definitions

Sound is the rapid fluctuation of air pressure higher and lower than normal atmospheric pressure. The term noise is often used to mean unwanted or undesirable sound, but this is a very subjective matter depending upon the individual, and so the terms noise and sound are often considered interchangeable in normal usage. The frequency of the sound, or pitch, if it is a pure tone, is the number of fluctuations of air pressure each second. If the sound frequency is within a certain range, generally considered 20 to 20,000 cycles per second (Hertz), the sound is considered audible to most persons with good hearing. Another characteristic of sound is its relative loudness, usually measured in decibels (dB), a shorthand logarithmic unit which avoids having to deal in the extremely large numbers describing sound in its basic engineering units. In other words, 120 dB, which would be experienced by standing close to a modern jet airplane taking off, is not 120 times as loud as a sound of 1 dB (the very faintest sound which the ear can hear) but rather nearly one million times as loud. Examples of various common noise sources and their relative loudness are found on Page A-8 of the Appendix.

The basic issue in dealing with community and environmental noise is its effects, and the way it is perceived by most persons. (See the Effects Section, page A-6). Therefore the noise must be measured, described and then compared to guidelines, regulations, and known effects. For these purposes the decibel is used with an "A weighting" function, meaning only that the lower and higher frequencies are de-emphasized similar to human hearing, rather than having a "flat" frequency response (which the stereo industry considers standard). Unless otherwise stated all references to decibels

relative to human effects and community noise are "A-weighted" decibels, or dBA, in the usual abbreviated form. These weighted decibel values are then referred to as noise levels, or sound levels. The equipment used to measure noise levels is called a Sound Level Meter.

In spite of the tendency to describe environmental noise levels with single-number descriptors for simplicity, the most characteristic feature of the noise people experience in their urban communities is its extreme variability. So to better understand what a given noise environment is really like, more information about it is often presented by using more than one descriptor. For example, the average noise level may be accompanied by the maximum or highest noise level, and also the minimum noise level occurring during a particular time period. In some cases it is more important to know that, for example, the minimum noise level is 45 dBA and the maximum noise level is 90 dBA, than that the average noise level is 55 dBA.

There are literally dozens of different types of noise descriptors, each developed to give information on the effects of specific types of noise under certain conditions--for aircraft noise, for speech intelligibility, and for activity interference. But in recent years most governmental agencies in the U.S. have been recommending use of either L_n , L_{eq} , or L_{dn} . L_n , where n is a number in percent, refers to the noise level in dBA which is exceeded n percent of the time. For example, traffic noise may be generated along a freeway such that at 100 feet from the roadway 70 dBA is exceeded ten percent of the time (and ninety percent of the time the noise is less than 70 dBA). The L_{10} noise level for that location is then 70 dBA. The L_{50} , or median noise level, is also often used as a descriptor. The equipment for measuring statistical noise descriptors is called a Noise Distribution Analyser.

L_{eq} is the energy equivalent noise level, otherwise defined as the single steady noise level which has the same sound energy as the actual widely-varying noise level being described. L_{dn} is essentially the same as L_{eq} except that during the night time period from 10:00 p.m. to 7:00 a.m. a 10 dB "penalty" is added to account for the expectation of a more quiet environment at night. In other words, a location with a 55 dBA daytime L_{eq} would only have an L_{dn} of 55 if the noise level during the night dropped at least 10 dBA. California's CNEL is basically equal to L_{dn} .

The ambient noise level refers to the combination of all sources of noise which make up the noise experienced at a given location. The background noise refers to the combination of distant sources which determine the minimum sound levels in any location. In statistical descriptors the L_{90} or L_{99} level is often used as a measure of the background noise level.

To more readily be able to understand and compare the differences in noise levels from one location to another, equal noise contours are often developed for a given site. Contours can be constructed for L_{10} , L_{dn} , L_1 , or any other appropriate descriptor, depending upon their intended purpose. Most often, L_{10} or L_{dn} contours are used, joining locations on a site which have the same L_{10} or L_{dn} noise levels in 5 dB increments, similar to joining places of equal elevation on a topographic contour map. Noise contours are helpful and effective in land use planning and in developing noise mitigation measures.

Two concepts are particularly important in dealing with noise mitigation, noise reduction, or noise attenuation, three terms having the same meaning in general usage. Each term means to lower noise levels in the area of concern through one or more techniques. Reflection is one common noise reduction method, which diverts sound energy from a location of high impact

to an area of less impact, such as with a noise barrier. Noise absorption is a mechanism by which some materials, such as thick grass outdoors, or spun fiberglass batts (home insulation), convert incident sound energy into heat rather than reflecting it.

Mathematical noise models are often used in making analyses of noise environments as a supplement to normal field noise measurements, or for projecting future noise conditions which cannot be measured. Noise modeling refers to using previously measured and analysed relationships between noise source characteristics and physical and geometrical conditions to estimate noise levels. A number of models for projecting aircraft noise, highway vehicle noise and railroad noise have been developed by or under contract to several governmental agencies, and are presently in widespread use and acceptance.

APPENDIX

THE EFFECTS OF NOISE ON PEOPLE

Noise is a part of our modern society -- noise from motorized labor-saving devices, transportation vehicles, and recreation devices. The use or conversion of energy for any purpose is seldom accomplished silently. We as humans have a capacity to tolerate or ignore a certain amount of our noise environment. But adverse effects are present in many exposures to noise, and dangers to health other than outright hearing impairment are also recognized.

The problem of controlling noise is difficult because it affects each individual in a different way. People do not hear sounds alike, nor do they perceive sounds similarly, hence they do not react to sounds in the same way. First of all, each person's reaction to noise will depend on characteristics of the noise itself:

1. loudness or intensity
2. Frequency content
3. duration
4. repetition rate
5. time of occurrence
6. unfamiliarity or uniqueness.

But the effect of noise on people is also determined by characteristics of the listener or the situation:

7. background or ambient noise level
8. individual sensitivity to noise
9. activity or preoccupation of listener
10. perceived need or justification for noise.

A combination of factors determines how much a person will be disturbed by a noise, depending upon the individual, the noise, and the situation, but the effect will fall into one of the following categories: physiological effects, psychological/emotional effects, and activity interference.

As an orientation to the use of the decibel as a measure of relative loudness, a list of common noise sources and their approximate sound levels are given in Page A-8.

Physiological Effects

At relatively high noise levels above 80 dBA, the delicate internal ear mechanism can be altered to cause Temporary Threshold Shift (TTS), resulting in partial deafness for a period of a few minutes to a few weeks, depending upon the noise level and the exposure time. If these excessive levels over 80 dBA are continued over long periods of time -- for example, 8 hours per day for several years, or if very high levels (over 100dB) are experienced for shorter periods, Permanent Threshold Shift (PTS) may result, meaning that irreversible loss in normal hearing capacity has occurred.

Fortunately, few exposures to levels causing hearing damage occur in the general community noise environment. However, some problems may occur for those choosing to attend or participate in musical and recreational events with high sound levels, or for persons engaged in occupations involving high noise levels (Occupational noise is regulated by State and Federal Occupational Safety and Health Regulations). But the potential for other less obvious noise effects exists throughout a normal daily schedule -- at home, school, shopping center, park, or highway. These various noise impacts can cause subtle physical, mental, and emotional stresses of varying degrees of seriousness.

Activity Interference

Noise disrupts human activities such as sleep, conversation, or stereo and TV enjoyment. Studies have shown that noise not only may prevent sleep by its intensity or characteristics but may seriously disturb the quality of sleep without fully awakening the sleeper. Conditions such as these -- community noises causing bedroom levels between 35-50 dBA -- are encountered to some extent throughout all urbanized areas. At noise levels over 55 dBA all types of normal listening activities are disrupted by noise. Speech intelligibility drops sharply, music listening and TV watching become strained, and aural communications in general must be carried out at much higher volumes to be successful. Obviously, shouting to be heard and understood is both undesirable and unpleasant for all concerned.

Psychological and Emotional Impacts

Less well documented and understood, but probably more widely experienced, are those impacts of noise which cause such subtle effects as distraction, annoyance, startle, privacy or relaxation interruption, stress, and tension. These effects as a class can, if continued, cause very serious emotional and psychological anxieties and disturbances. Often the cause of these reactions is not directly related to the noise environment, as the listener is not consciously aware of the noise intrusion. He may only be aware of an increased irritability and uneasiness. Our unusual human ability to "tolerate" or "adapt to" disturbing noise levels thus can incur a penalty upon our subconscious body processes over an unusually wide range of noise levels. So protection against the intrusion of disturbing noise is particularly important to mental and emotional health in an active and complex urban community.

TYPICAL NOISE SOURCES	NOISE LEVEL (dBA)	TYPICAL HUMAN RESPONSE
Jet aircraft take off (50')	130	
Auto horn (3')	120	Pain & Hearing Damage
Rock music in a night club	110	
	105	Possible Permanent Hearing damage
Motorcycle accelerating, no muffler (25')	100	
	95	Temporary Hearing Loss
Motorcycle accelerating, stock muffler (25')	90	Uncomfortable
Food blender (3')	80	Very Disturbing
Power lawn mower (20')		
Steady urban traffic (25')	70	Communications Difficult
Normal conversation (3')	60	
Daytime street, no nearby traffic	50	
	45	Sleep Disturbance
Quiet office	40	
Inside quiet home. Soft whisper (10')	30	Very quiet
Movie or recording studio	20	Seldom-experienced ambient
	10	Barely audible
Threshold of hearing	0	

A decibel "A-weighted" (dBA) is a unit of measurement indicating the relative intensity of a sound as it is heard by the human ear. An increase of 10 dBA indicates a noise level increase of about three times, but only a doubling in perceived loudness.

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